APPLICATION FOR UNITED STATES PATENT

FOR

WAFER GRINDING USING AN ADHESIVE GEL MATERIAL

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TECHNICAL FIELD & BACKGROUND

The present disclosure is related to the field of semiconductor device manufacturing and packaging. More specifically but not exclusively, the present disclosure is related to semiconductor wafer grinding using an adhesive gel material.

Semiconductor wafers are usually thinned prior to the assembly of individual semiconductor devices. Such thinning is often accomplished by wafer grinding or "backgrinding" since it is usually done by mechanically grinding a lower surface (i.e., back) of a wafer. A conventional method of protection is the application of a "backgrind" tape or grinding protection tape over an active or upper surface of the wafer to protect integrated circuits or other surface structures on the wafer during grinding. Among the disadvantages of using such tape is that tape selection for various wafer types (for example, wire bond, flip chip and alternative bumped method wafer types) can be time-consuming and complicated. Furthermore, wafer taping and de-taping adds expense and processing time to wafer packaging and may damage a wafer surface by leaving behind adhesive residue and damaged or missing wafer bumps when the tape is removed.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be described by way of exemplary embodiments, but not limitations, illustrated in the accompanying drawings in which like references denote similar elements, and in which:

Figures 1 and 2 illustrate two prior art semiconductor wafer grinding and dicing methods;

Figure 3 illustrates a cross-sectional view of a prior art vacuum chuck used in the prior art semiconductor wafer grinding and dicing methods of **Figs. 1 and 2**;

Figures 4a and 4b illustrate enlarged cross-sectional views of a wafer on a platform according to embodiments of the invention.

Figures 5 and 6 illustrate cross-sectional views of the vacuum chuck of **Fig.3** and placement of a wafer thereon in accordance with embodiments of the invention;

Figures 7 and 8 illustrate methods for semiconductor wafer grinding and dicing in accordance with embodiments of the invention.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

Embodiments of the present invention include, but are not limited to, methods for semiconductor wafer grinding using an adhesive gel material.

Various aspects of the illustrative embodiments will be described using terms commonly employed by those skilled in the art to convey the substance of their work to others skilled in the art. However, it will be apparent to those skilled in the art that the present invention may be practiced with only some of the described aspects. For purposes of explanation, specific numbers, materials and configurations are set forth in order to provide a thorough understanding of the illustrative embodiments. However, it will be apparent to one skilled in the art that embodiments of the present invention may be practiced without the specific details. In other instances, well-known features are omitted or simplified in order not to obscure the illustrative embodiments.

Various operations will be described as multiple discrete operations, in turn, in a manner that is most helpful in understanding the present invention, however, the order of description should not be construed as to imply that these operations are necessarily order dependent. In particular, these operations need not be performed in the order of presentation.

The phrase "in one embodiment" is used repeatedly. The phrase generally does not refer to the same embodiment, however, it may. The terms "comprising", "having" and "including" are synonymous, unless the context dictates otherwise.

Embodiments of a method for semiconductor wafer grinding using an adhesive gel material are described herein. For simplicity and clarity of explanation, various embodiments of the invention are shown in the figures

according to various views. It is to be appreciated that such views are merely illustrative and are not necessarily drawn to scale or to the exact shape. Furthermore, it is to be appreciated that the actual devices utilizing principles of the invention may vary in shape, size, configuration, contour, and the like, other than what is shown in the figures, due to different manufacturing processes, equipment, design tolerances, or other practical considerations that result in variations from one semiconductor device to another.

Figures 1 and 2 illustrate example prior art semiconductor wafer grinding and dicing methods. In **Figure 1,** a prior art semiconductor wafer grind-before-dice method is shown. Backgrind tape or grinding protection tape **102** is first taped to a semiconductor wafer **104** (hereinafter, simply "wafer") to protect integrated circuits or other surface structures formed on an active or upper surface **105** of wafer **104**. With grinding protection tape **102** attached to upper surface **105** of wafer **104**, wafer **104** may then be mounted, face down, to a surface or platform **114** of vacuum chuck **106**. Vacuum chuck **106** may apply a suction or vacuum to hold wafer **104** and grinding protection tape **102** which is adhesively attached to wafer **104**, to vacuum chuck **106**. Once wafer **104** is suctioned face-down to vacuum chuck **106**, wafer **104** may now be ready to be thinned by removing material from a back side or a lower surface **109** (untaped side) of wafer **104** by a grinding chuck **108**.

After the grinding process, grinding protection tape **102** may be removed or de-taped from upper surface **105** of wafer **104**. Wafer **104** may then be mounted with a wafer mount tape **112** applied to lower surface **109** of wafer **104**. Wafer **104** may then be singulated or diced at **116** into separate integrated circuit die or a plurality of integrated circuit die.

Another variation of the above prior art process can be used. **Figure 2** illustrates a prior art method called dice-before-grind ("DBG"), which moves dicing to the start of the process and eliminates the handling of very thin ground wafers as a whole. In **Figure 2**, wafer **104** may be diced at **116** to a depth slightly deeper than a final desired wafer thickness. Grinding protection tape **102** may be attached to upper surface **105** of wafer **104**. As in **Figure 1**, wafer **104** may then be mounted, face down, to platform **114** of vacuum chuck **106** so that lower surface **109** may be thinned by grinding chuck **108**. Then, lower surface **109** of wafer **104** may be mounted with wafer mount tape **112** and grinding protection tape **102** may then be removed.

Figure 3 illustrates a cross-sectional view of prior art vacuum chuck **106** of **Figures 1 and 2**. Vacuum chuck **106** may include a porous material **304** through which air flow or a vacuum **308** may be applied. Platform **114** of vacuum chuck **106** may generally include a surface that, although porous, may be hard and may damage wafer **104** if grinding protection tape **102** is not used to help absorb some of the grinding pressure, force, and vibration.

Figures 4a and 4b illustrate embodiments wherein an adhesive gel material or gel material **404** may rely on a changing surface contact area between wafer **104** and gel material **404** to hold or, in the alternative, release wafer **104**. As illustrated, for the embodiment, **Figure 4a** shows that gel material **404** may include a gel membrane **410**. For the embodiment, gel material **404** may include adhesive properties to allow gel material **404** to act as a bonding agent between two surfaces when surface contact area is substantial. Thus, as shown in the embodiment of **Figure 4a**, substantial surface contact between gel membrane **410** of gel material **404** and upper surface **105** of wafer **104** may hold wafer **104** in position on a platform **114** during grinding. Platform **114** may be a

surface of a vacuum chuck in one embodiment. Gel material **404** may be similar to gel material used in some instances for packing and shipping of wafers in an embodiment. For example, in one embodiment, gel material **404** may be a material such as for example, Gel-Pak™, available from Gel-Pak, Inc., located in Hayward, California, U.S.A.

In various embodiments, upper surface **105** of wafer **104** may include surface structures including electronic circuitry and related devices. Because gel material **404** may be of a semi-solid or semi-fluid nature, gel material **404** may be able to fill in one or more recesses or depressions of wafer **104**, therefore increasing surface area contact while increasing adhesion and cushioning properties. Platform **114** may include a vacuum in the embodiment and is turned off in Figure **4a**.

In **Figure 4b**, in order to allow gel material **404** to release wafer **104** from platform **114** after grinding is finished, the vacuum may be applied to gel material **404** in the embodiment. As illustrated by depressions in gel membrane **410**, surface contact between wafer **104** and gel material **404** may be reduced or minimized as the vacuum draws gel membrane **410** away from inverted upper surface **105** of wafer **104** and toward platform **114** to lessen a holding strength of gel material **404**. Note that in the embodiment, gel material **404** may include semi-solid particles **406** to prevent total or substantial collapse of gel membrane **410** to reduce surface contact between gel membrane **410** and upper surface **105** to release wafer **104** from platform **114** when the vacuum is activated. Note that for the embodiment, semi-solid particles **406** may be comprised of any organic, inorganic, or synthetic semi-solid material suitable to prevent total or substantial collapse of gel membrane **410** when the vacuum is activated. In one embodiment, for example, semi-solid particles **406** may be comprised of a similar

material to gel material **404** but with a more solid composition. In other embodiments, semi-solid particles **406** may be comprised of any suitable material which would be familiar to those in the art having the benefit of this disclosure.

Figures 5 and 6 illustrate cross-sectional views of vacuum chuck **106** wherein gel material **404** including semi-solid particles **406** (See **Figs. 4a and 4b**) replaces grinding protection tape **102** of **Figure 3** in one embodiment. In the embodiment, gel material **404** may be applied to upper surface **105** of wafer **104**. In other embodiments, gel material **404** may be applied to platform **114** of vacuum chuck **106**. For the embodiment, in order for wafer **104** to be held securely in place by gel material **404** to vacuum chuck **106**, vacuum chuck **106** may not be activated. For the embodiment, gel material **404** may be able to protect wafer **104** by absorbing pressure, force, and vibration that grinding protection tape, such as grinding protection tape **102,** of **Figs. 1-3** would normally absorb.

Figure 6 shows that, in one embodiment, when vacuum chuck **106** is activated, gel material **404** may be substantially pulled off upper surface **105** of wafer **104** to allow gel material **404** to release wafer **104** from vacuum chuck **106**. In the embodiment, vacuum **308** may be applied in a downward direction through porous material **304** of vacuum chuck **106**. Thus, for the embodiment, wafer **104** is removed from vacuum chuck **106** by reducing surface contact between gel material **404** and upper surface **105** of wafer **104**. Note that in various embodiments, gel material **404** may be of a pliable consistency and may hold various types of wafers including flip-chip bump and non-bump wafers without damaging surface structures on the wafer.

Figures 7 and 8 illustrate wafer grinding and dicing processes without the use of grinding protection tape **102** in embodiments of the invention. **Figure 7** shows a wafer grind-before-dice process but with the use of gel material **404** rather than grinding protection tape **102**, in one embodiment. Resultantly, the process may be simplified as compared to the grind-before-dice process shown in **Figure 1**. In the embodiment shown in **Figure 7**, wafer **104** may be positioned face-down onto vacuum chuck **106** so that gel material **404** may be between platform **114** and upper surface **105** of wafer **104** to maximize or provide substantial surface contact between gel material **404** and upper surface **105.** For the embodiment, in order for gel material **404** to hold wafer **104** in place, vacuum chuck **106** may not be activated as grinding chuck **108** grinds lower surface **109** of wafer **104**. Once the grinding is finished, wafer **104** may be released from vacuum chuck **106** by activating vacuum chuck **106**. In the embodiment, surface contact between gel material **404** and upper surface **105** of wafer **404** including any surface structures of wafer **404** may be reduced. Wafer **104** may then be mounted with wafer mount tape **112**. In another embodiment, a vacuum transfer arm or device may be used to transfer wafer **404** from vacuum chuck **106** onto a mounting surface. Wafer **104** may then be diced at **116** into separate integrated circuit die or a plurality of integrated circuit die. Wafer **104** may also be washed before grinding and at various stages in the embodiment. In the embodiment, the process is simplified as the taping and de-taping processes of **Figs. 1 and 2** may be eliminated.

Figure 8 illustrates one embodiment of the dice-before-grind method including the use of gel material **404** rather than grinding protection tape **102** of the process shown in **Figure 2**. In the embodiment, wafer **104** may be partially diced at **116** to a depth slightly deeper than a final desired wafer thickness. Gel

material **404** may be applied to upper surface **105** (see **Fig. 5**) of wafer **104** which is then positioned on vacuum chuck **106** to allow gel material **404** to hold wafer **104** against platform **114** of vacuum chuck **106**. Vacuum chuck **106** is not activated as grinding chuck **108** grinds lower surface **109** of wafer **104** in the embodiment. In the embodiment, gel material **404** may absorb the type of grinding force, pressure, and vibration that a grinding protection tape such as grinding protection tape **102** normally would. When wafer **104** is thinned to a desired thickness, vacuum chuck **106** may be activated to allow gel material **404** to release wafer **104** from platform **114** of vacuum chuck **106**. For the embodiment, semi-solid particles **406** (see **Fig. 4b**) within gel material **404** may form a structure to substantially prevent the gel membrane surface from collapsing to vacuum chuck **106** when the vacuum chuck is activated. Wafer **104** may then be mounted with wafer mount tape **112**. In one embodiment, wafer **104** may remain or rest on platform **114** of vacuum chuck **106** until wafer **104** may be mounted with wafer mount tape **112**.

Thus, it can be seen from the above descriptions, one or more novel methods for semiconductor wafer grinding without the use of grinding protection tape have been described. While the present invention has been described in terms of the foregoing embodiments, those skilled in the art will recognize that the invention is not limited to the embodiments described. The present invention can be practiced with modification and alteration within the spirit and scope of the appended claims.

Thus, the description is to be regarded as illustrative instead of restrictive on the present invention.